a second measurement system for measuring an average deviation of the stage;

and

an arithmetic section for calculating the position of the mark at a state that the stage is at rest on the basis of a first measurement result by said first measurement system and a second measurement result by said second measurement system.--.

REMARKS

Applicant requests favorable reconsideration and allowance of the subject application in view of the preceding amendments and the following remarks.

To place the subject application in better form, the specification has been amended to correct minor informalities. No new matter has been added by these changes.

Claims 1-26 are presented for consideration. Claims 1, 11, 23, 24 and 26 are independent. Claims 1-6, 9, 11, 12, 15-17 and 21-25 have been amended to clarify features of the invention, while Claim 26 has been added to recite additional features of the invention. Support for these changes can be found in the application, as originally filed. Therefore, no new matter has been added.

Claims 1-5, 7-9, 11-15, 17-19 and 21-25 stand rejected under 35 U.S.C. § 102 over U.S. Patent No. 5,760,878 (Ogushi). Claims 6, 10, 16 and 20 stand rejected under 35 U.S.C. § 103 over the Ogushi patent. Applicant traverses these rejections.

As recited in independent Claim 1, Applicant's invention is directed to a detection apparatus for detecting a position of a mark formed on an object placed on a stage. The

apparatus includes an image sensing system arranged to obtain image data by sensing an image of the mark formed on the object, and a measurement system arranged to obtain average data of a position deviation of the stage. An arithmetic section is arranged to calculate the position of the mark at a state in which the stage is at rest on the basis of the image data obtained by the image sensing system and the average data obtained by the measurement system.

As recited in independent Claims 11, 23, 24 and 26, Applicant's invention is directed to measuring a position of a mark formed on a substrate or an object, and measuring an average deviation of a stage on which the substrate or object is placed. The invention further involves calculating the position of the mark at a state in which the stage is at rest on the basis of those two measurements.

The Ogushi patent is directed to an exposure apparatus having an X-Y stage 101 and a laser distance measuring device 106 for detecting a position of the X-Y stage 106. In the described apparatus, average and standard deviation are calculated based on positional deviation information obtained by measuring device 106. Error shock discrimination is then executed based on those calculations. The Ogushi patent also discloses pickups 504, which substitute for measuring device 106, for detecting a positional deviation between reticle 502 and wafer 103. Applicant submits, however, that the Ogushi patent does not describe using both position information of the X-Y stage 106 and image data of a mark on the substrate in order to calculate a position of a mark at a state in which the stage is at rest.

Accordingly, Applicant submits that the Ogushi patent fails to disclose or suggest at least the features of an image sensing system arranged to obtain image data by sensing an image of a mark formed on an object, a measuring system arranged to obtain average data of a position

deviation of a stage, and an arithmetic section arranged to calculate the position of the mark at a state that the stage is at rest on the basis of the image data obtained by the image sensing system and the average data obtained by the measuring system, as recited in independent Claim 1. In addition, Applicant submits that the Ogushi patent fails to disclose or suggest at least the features of measuring a position of a mark formed on a substrate or object, measuring an average deviation of a stage, and calculating the position of the mark at a state that the stage is at rest on the basis of those measurement results, as recited in independent Claims 11, 23, 24 and 26.

For the foregoing reasons, Applicant submits that the independent claims are allowable over the applied patent, and requests withdrawal of the rejections under §§ 102 and 103.

The dependent claims also should be deemed allowable, in their own right, for defining other patentable features of the present invention in addition to those recited in their respective independent claims. Further individual consideration of these dependent claims is requested.

Applicant further submits that the instant application is in condition for allowance. Favorable reconsideration, withdrawal of the objection and rejections set forth in the above-noted Office Action and an early Notice of Allowance are requested.

Applicant's undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should be directed to our address listed below.

Respectfully submitted,

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Application No. 09/343,093
Attorney Docket No. 00862.002907.

APPENDIX A

IN THE SPECIFICATION:

Please substitute the paragraph beginning at page 1, line 7, with the following.

-- The present invention relates to a position detection apparatus and an exposure apparatus and, more particularly, to a detection apparatus for detecting the position of a mark formed on an object placed on a stage, and an exposure apparatus including the apparatus. --

Please substitute the paragraph beginning at page 1, line 20, with the following.

-- The present invention is also preferably applied to an apparatus for manufacturing semiconductor devices such as ICs or LSIs, image sensing devices such as CCDs, display devices such as liquid crystal panels, or devices such as magnetic heads, and for example, to a proximity exposure apparatus, a projecting exposure apparatus (a so-called stepper), or a scanning exposure apparatus. --

Please substitute the paragraph beginning at page 3, line 26, and ending on page 4, line 6, with the following.

-- In observing an alignment mark on a wafer, the stage is driven. Especially, since alignment marks of a plurality of shots are observed in global alignment, the stage must be driven a [plurality of] number of times. To improve the throughput, every time the alignment mark in one shot is sequentially moved to the mark observation position, the stage must be quickly accelerated and stopped. --

Please substitute the paragraph beginning at page 5, line 11, with the following.

-- According to the first aspect of the present invention, there is provided a position detection apparatus for detecting a position of a mark formed on an object placed on a stage, comprising an image sensing system averaging an image signal obtained by sensing an image of the mark formed on the object, a measurement system obtaining average data of a position deviation of the stage, and an arithmetic section calculating the position of the mark at a state that the stage is at rest on the basis of image data [average] <u>averaged</u> by the image sensing system and a measurement result by the measurement system. --

Please substitute the paragraph beginning at page 12, line 15, with the following.

-- Fig. 7 is a view schematically showing the relationship between an off-axis scope (OE), <u>a</u> reduction projecting lens (LN), <u>a</u> target stage position, and <u>an</u> actual stage position; --

Please substitute the paragraph beginning at page 12, line 18, with the following.

-- Fig. 8 is a perspective view schematically showing the arrangement of the principal part of an exposure apparatus with an inspection function according to another preferred embodiment of the present invention; --

Please substitute the paragraph beginning at page 13, line 10, with the following.

-- Fig. 1 is a perspective view schematically showing the principal part of a projecting exposure apparatus according to the first embodiment of the present invention. Fig. 2 is a block diagram showing the principal part of the projecting exposure apparatus according to the first embodiment of the present invention. Figs. 3 to 5 are flow charts schematically showing the operation of the projecting exposure apparatus shown in Figs. 1 and 2. Fig. 6 is a view schematically showing an alignment mark in one shot on a wafer, which is applied to the projecting exposure apparatus shown in Figs. 1 and 2. Fig. 7 is a view schematically showing the relationship between an off-axis scope (OE), a reduction projecting lens (LN), an actual stage driving position, and a target stage driving position. --

Please substitute the paragraph beginning at page 13, line 24, and ending on page 14, line 11, with the following.

-- A projecting exposure apparatus (stepper) ST according to the first embodiment of the present invention comprises a reticle holder RH for holding a reticle RT, an off-axis scope OE as an image sensing section for sensing image of alignment marks (to also be simply referred to as marks) WAMX and WAMY on a wafer WF, XY stage XYS and θ stage θs for moving the wafer

WF, laser interferometer IFX and mirror MRX for measuring the position or deviation (difference between the target position and actual position) of the XY stage in the X direction, laser interferometer IFY and mirror MRY for measuring the position or deviation of the XY stage in the Y direction, laser interferometer IFθ (mirror MRX is shared) for measuring the rotation amount or deviation of the XY stage, and control unit CU, as shown in Fig. 1. --

Please substitute the paragraph beginning at page 18, line 5, with the following.

-- A method of detecting a shift amount of the mark position, which is used in step S003 of Fig. 3 (alignment by the global alignment scheme), will be described next with reference to Fig. 2 and the flow charts of Figs. 4 and 5. --

Please substitute the paragraph beginning at page 25, line 13, and ending on page 26, line 1, with the following.

-- In the above example, the shift amount (position) of a mark measured by the off-axis scope before the stage completely stops is corrected on the basis of the measurement results of average deviations of the stage, which are measured by the laser interferometers in the X and Y directions. However, evaluation need not always be done by this method. The measured mark position may be corrected using the stage deviation except those along the X and Y [axis] axes. The stage position may be measured by a measurement instrument of another type. The mode determination section 600 determines the correction mode (e.g., an arithmetic expression to be used for correction) in accordance with setting for devices such as laser interferometers to be used, installation state of the apparatus, floor state, and the like. --

Please substitute the paragraph beginning at page 27, line 10, with the following.

-- Fig. 8 is a perspective view schematically showing the arrangement of the principal part of an exposure apparatus with an inspection function according to the second embodiment of the present invention. This apparatus has a coater CO, projecting exposure apparatus ST, and developer DE. The coater CO has a function of applying a resist to a wafer WF. The developer DE has a function of developing an inspection wafer exposed by the projecting exposure apparatus ST. Fig. 2 is a block diagram showing the principal part of the projecting exposure apparatus ST. --

Please substitute the paragraph beginning at page 27, line 20, and ending on page 28, line 7, with the following.

-- In this exposure apparatus with an inspection function, the projecting exposure apparatus ST is automatically inspected while moving an inspection wafer placed at the entrance of the coater CO between the apparatuses CO, ST, and DE in accordance with an instruction from a control unit CU. More specifically, an alignment mark pattern is transferred to the resist on an inspection wafer by exposure using the projecting exposure apparatus ST, and the wafer is developed to form an alignment mark. After this, the position of the mark is measured in the projecting exposure apparatus ST. In this exposure apparatus with an inspection function, the correction mode is determined on the basis of the mark position measurement result (SA110 in Fig. 10). --

Please substitute the paragraph beginning at page 28, line 8, with the following.

-- Additionally, in this exposure apparatus with an inspection function, for example, the alignment accuracy or process offset value is calculated on the basis of the mark position measurement result. These results are used as correction values for wafer alignment in the projecting exposure apparatus ST. --

Please substitute the paragraph beginning at page 28, line 17, with the following.

-- The operation of the exposure apparatus with an inspection function according to the second embodiment will be described next with reference to Figs. 8 and 9. Processing shown in Fig. 9 is controlled by the control unit CU. The apparatuses and control unit CU are connected through communication cables. --

Please substitute the paragraph beginning at page 29, line 17, with the following.

-- When exposure of all shots is ended, the wafer WF is sent from [then] the wafer chuck WS to a loading path R3 of the developer (developing apparatus) DE by a recovery handler HAR (S105). --

Please substitute the paragraph beginning at page 31, line 1, with the following.

-- Image signals from the CCD camera CMY are processed by the control unit CU to measure the position of the alignment marks WML and WMR in the Y direction. As in the first embodiment, this measurement is executed before the XY stage XYS comes to a complete stop. As measurement results, average shift amounts of the marks during the observation period are

obtained. These measurement results are corrected on the basis of the average deviation of the stage XYS during the observation period, which is measured by a laser interferometer, to calculate the actual shift amounts of the marks. At this time, 3σ associated with a variation in deviation of the stage XYS is also calculated, as in the first embodiment. --

Please substitute the paragraph beginning at page 32, line 2, with the following.

-- After global alignment is ended, virtual exposure for the wafer WF is executed sequentially from the first shot to the final shot while driving the XY stage XYS by the step and repeat scheme (S110). At this time, light from the exposure light source IL passes through the masking blade MB and reticle RT and enters the projecting lens LN. The image of a pattern formed on the reticle RT is reduced to 1/5 by the projecting lens LN and projected [on to] onto the resist applied to the wafer WF. When one shot is exposed, the XY stage XYS moves to execute exposure of the next shot. --

Please substitute the paragraph beginning at page 33, line 6, with the following.

-- In step SA103, an image sensing control section 300 causes the CCD camera CMY to start storage of the mark image before the stage (XYS and θs) 900 completely stops, i.e., when the stage 900 is still swinging, and to continue this storage until a predetermined observation time elapses. --

Please substitute the paragraph beginning at page 37, line 25, and ending on page 38, line 6, with the following.

-- In step SAS016, the stage deviation storage section 400 sends a sync signal representing <u>an</u> end of observation to the image sensing control section 300. In step SAS017, the stage deviation storage section 400 calculates average deviations dx and dy of the stage (XYS and θS) 900 in the X and Y directions, and 3σ of the deviations on the basis of the position deviation data stored in the memory 2000, and stores the values in the memory 2000. --

Please substitute the paragraph beginning at page 39, line 2, with the following.

-- The shift amount (position) is the average value of shift amounts from the target position of the mark which is moving at a constant speed during the observation period. The average deviation calculated in step SAS007 is <u>the</u> average deviation from the target position of the stage 900 which is moving at a constant speed during the observation period. Hence, when the mark shift amount calculated in step [SAC014] <u>SAS014</u> is corrected on the basis of <u>the</u> average deviation of the stage 900, which is calculated in step SAS017, the actual shift amount of the mark on the stage 900 from the target position can be calculated.--

Please substitute the paragraph beginning at page 41, line 17, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- In step 6 (inspection), inspections including <u>an</u> operation check test and <u>a</u> durability test of the semiconductor device manufactured in step 5 are performed. A semiconductor device is completed with these processes and delivered (step 7). –

Please substitute the paragraph beginning at page 41, line 17, with the following.

--In step 6 (inspection), inspections including <u>an</u> operation check test and <u>a</u> durability test of the semiconductor manufactured in step 5 are performed. A semiconductor device is completed with these processes and delivered (step 7).--

Please substitute the paragraph beginning at page 42, line 13, with the following.

-- When the manufacturing method of this embodiment is used, a semiconductor device with <u>a</u> high degree of integration, which is conventionally difficult to manufacture, can be manufactured.--

<u>IN THE CLAIMS</u>:

Please amend Claims 1-6, 9, 11, 12, 15-17 and 21-25, as follows.

1. (Amended) A detection apparatus [(ST)] for detecting a position of a mark [(WAMX, WAMY)] formed on an object [(WF)] placed on a stage, comprising:

an image sensing system [(MCX, MCY) averaging an image signal obtained] <u>arranged to obtain image data</u> by sensing an image of the mark [(WAMX, WAMY)] formed on the object [(WF)];

a measurement system [obtaining] <u>arranged to obtain</u> average data [(dx, dy] of a position deviation of the stage; and

an arithmetic section [calculating] <u>arranged to calculate</u> the position [(MCX - dx, MCY - dy)] of the mark at a state that the stage is at rest on the basis of <u>the</u> image data [average]

obtained by said image sensing system and [a measurement result (dx, dy)] the average data obtained by said measurement system.

2. (Amended) The apparatus according to claim 1, wherein

said image sensing system stores [image signals associated with] the image of the mark during a predetermined observation period and obtains the image data used for determining an average position [(MCX, MCY)] of the mark during the observation period on the basis of the stored image [signals].

3. (Amended) The apparatus according to claim 1, wherein

said image sensing system and said measurement system [measure an average image signal] obtain the image data of the mark and the average deviation [(dx, dy)] of the stage during substantially the same observation period, respectively.

4. (Amended) The apparatus according to claim 1, wherein

after the stage moves to a position where said [measurement] image sensing system can [measure the position] sense the image of the mark and before the stage stops, said image sensing system and said measurement system start image sensing and measurement to obtain [an average image signal] the image data of the mark and the average data of the position deviation of the stage, respectively.

5. (Amended) The apparatus according to claim 1, wherein

said image sensing system comprises an off-axis scope [(OE)].

6. (Amended) The apparatus according to claim 1, wherein

said measurement system comprises an interferometer [(IFX, IFY, IFθ, MRX, MRY)].

9. (Amended) The apparatus according to claim 1, wherein

in an area where said sensing system can [measure the position] sense the image of the mark, said image sensing system and said measurement system execute image sensing and measurement to obtain [an average image signal] the image data of the mark and the average data of the position deviation of the stage, respectively, while moving the stage at a predetermined speed, and said arithmetic section calculates the position of the mark[, while] at a state that the stage is at rest[,] on the basis of the [measurement results] image data and the average data.

11. (Amended) An exposure apparatus comprising:

a stage moving a substrate [(WF) placed on a stage] thereon;

a projecting lens [(LN)] projecting a pattern onto the substrate [(WF)];

first measurement means for measuring a position [(MCX, MCY)] of a mark [(WAMX, WAMY)] formed on the substrate [(WF) on the basis of an average image signal of the mark];

second measurement means for measuring an average deviation [(dx, dy)] of said stage;

calculation means for calculating the position [(MCX - dx, MCY - dy)] of the mark at a state that said stage is at rest on the basis of a measurement result [(MCX, MCY) by] of said first measurement means and a measurement result [(dx, dy) by] of said second measurement means; and

positioning means for driving said stage on the basis of a calculation result by said calculation means to position the substrate [(WF)] at a target position.

12. (Amended) The apparatus according to claim 11, wherein

said first measurement means comprises image sensing means for sensing an image of the mark, said image sensing means storing [image signals associated with] the image of the mark during a predetermined observation period and obtaining an average position of the mark during the observation period on the basis of the stored image [signals].

15. (Amended) The apparatus according to claim 11, wherein

said first measurement means comprises an off-axis scope [(OE)].

21. (Amended) The apparatus according to claim 11, further comprising

determination means for determining a calculation mode to be applied when said calculation means calculates the position of the mark [while] at a stage that said stage is at rest.

22. (Amended) The apparatus according to claim 21, wherein

said determination means determines the [correction] <u>calculation</u> mode on the basis of the position of the mark and the deviation of said stage, which are measured by said first measurement means and said second measurement means while placing, on said stage, an inspection substrate having a mark formed by exposing a pattern by said exposure apparatus.

23. (Amended) A detection method of detecting a position of a mark [(WMAX, WAMY)] formed on an object [(WF)] placed on a stage, comprising:

the first measurement step of measuring a position [(MCX, MCY)] of a mark [(WAMX, WAMY)] formed on the object [(WF) on the basis of an average image signal of the mark];

the second measurement step of measuring an average deviation [(dx, dy)] of the stage; and

the calculation step of calculating the position [(MCX - dx, MCY - dy)] of the mark at a stage that the stage is at rest on the basis of a measurement result [(MCX, MCY)] in the first measurement step and a measurement result [(dx, dy)] in the second measurement step.

24. (Amended) A method of controlling an exposure apparatus having a stage for moving a substrate [(WF)] placed [on a stage] <u>thereon</u>, and a projecting lens [(LN)] for protecting a pattern onto the substrate [(WF)], comprising:

the first measurement step of measuring a position [(MCX, MCY)] of a mark [(WAMX, WAMY)] formed on the substrate [(WF) on the basis of an average image signal of the mark];

the second measurement step of measuring an average deviation [(dx, dy)] of the stage;

the calculation step of calculating the position [(MCX - dx, MCY - dy)] of the mark at a state that the stage is <u>at rest</u> on the basis of a measurement result [(MCX, MCY)] in the first measurement step and a measurement result [(dx, dy)] in the second measurement step; and

the positioning step of driving [said] <u>the</u> stage on the basis of a calculation result in the calculation step to position the substrate [(WF)] at a target position.

25. (Amended) A method of manufacturing a device, comprising the steps of:

placing a substrate applied with a resist on a stage of [said] <u>the</u> exposure apparatus of claim 11;

aligning the substrate in [said] <u>the</u> exposure apparatus; and

transferring a pattern to the substrate in [said] <u>the</u> exposure apparatus.

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